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# 3. ABBREVIATIONS

DropBooks

| | |
|---|---|
| 2,3,4,6-TeCP | 2,3,4,6-tetrachlorophenol |
| 2,3-DMP | 2,3-dimethylpentane |
| 2,4,5-T | 2,4,5-trichlorophenoxyacetic acid |
| 2,4,5-TP | 2-(2,4,5-trichlorophenoxy)propionic acid |
| 2,4,6-TCP | 2,4,6-trichlorophenol |
| 2,4-D | 2,4-dichlorophenoxyacetic acid |
| 2,4-DCP | 2,4-dichlorophenol |
| 2,4-DMP | 2,4-dimethylphenol |
| 2-CP | 2-chlorophenol |
| 2-DNP | 2-dinitrophenol |
| 2-M-4,6-DNP | 2-methyl-4,6-dinitrophenol |
| 2-NP | 2-nitrophenol |
| 4-NP | 4-nitrophenol |
| AA | amino acid |
| AAA | amino acid compositional analysis |
| AAS | atomic absorption spectrometry |
| ACN | acetonitrile |
| ADAM | 9-anthryldiazomethane |
| ADC | analog-to-digital converter |
| AD-CSP | amylose *tris*-(3,5-dimethylphenylcarbamate) CSP |
| AE | alcohol ethoxylates |
| AEDA | aroma extract dilution analysis |
| AFM | atomic force microscopy |
| AGP | $\alpha_1$-acid glycoprotein |

| | |
|---|---|
| AMD | automated multiple development |
| AMW | acidic mine waters |
| ANN | artificial neural network |
| APCI | atmospheric pressure chemical ionization |
| APE | alkylphenol ethoxylates |
| API | atmospheric pressure ionization |
| AQC | 6-aminoquinolyl-*N*-hydroxysuccinimidyl carbamate |
| ASE | accelerated solvent extraction |
| ASE | Archimedean screw effect |
| ASP | amnesic poisoning |
| ASPEC | automated SPE clean-up |
| ASTM | American Society for Testing and Materials |
| b.p. | boiling point |
| BE | benzoylecgonine |
| BF | batch factor |
| BF | Best Foods |
| BGE | background electrolyte |
| BOD | biological oxygen demand |
| BPR | back-pressure regulator |
| BSA | bovine serum albumin |
| BSTFA | *N*,*O*-*bis*-(trimethylsilyl)trifluoroacetamide |
| BTEX | benzene, toluene, ethylbenzene, xylene |
| BTX | benzene, toluene, xylene |
| $C(GC)^2$ | comprehensive gas chromatography |
| c.m.c. | critical micellar concentration |
| CB | Contaminants Branch |
| CBH I | cellobiohydrolase I |
| CCC | countercurrent chromatography |
| CCDs | charged coupled devices |
| CCP | chiral coated phase |
| CD | cyclodextrin |
| CDCCC | centrifugal droplet countercurrent chromatography |
| CDR | chiral derivatization reagent |
| CE | capillary electrophoresis |
| CEC | capillary electrochromatography |
| CF-FAB | continuous flow – fast atom bombardment |
| CI | chemical ionization |
| CID | collision-induced dissociation |
| CLA | conjugated linoleic acid |
| CLD | chemiluminescence detector |
| CMA | chiral mobile-phase additive |
| CMP | chiral mobile phase |
| CMR | continuous membrane reactor |
| CoMFA | comparative molecular field analysis |
| CPC | coil planet centrifuges |
| CPF | co-current permeate flow |
| CPT | cone penetrometer |
| cSFC | supercritical fluid chromatography with a capillary column |
| CSP | chiral stationary phase |
| CTA | cellulose triacetate |
| CTAB | cetyltrimethylammonium bromide |
| CV | coefficient of variation |
| CXC | cation exchange chromatography |
| CZE | capillary zone electrophoresis |
| DA | domoic acid |

| | |
|---|---|
| DABITC | dimethylaminoazobenzene isothiocyanate |
| DABS | dimethylaminonaphthalene-5-sulfonyl |
| DAG | diacetonegulonic acid |
| DANS | 1-*N*, *N*′-dimethylaminonaphthalene-5-sulfonyl |
| DB-5 | 5% poly(diphenyldimethylsiloxane) |
| DBT | dibenzothiophene(s) |
| DBV | divinylbenzene |
| DCCC | droplet countercurrent chromatography |
| DCTFA | 1,2-dichlorotetrafluoroacetone |
| DEHPA | di(2-ethylhexyl)phosphoric acid |
| DETA | diethylenetriamine |
| DIA | deisopropylatrazine |
| DIC | diisopropylcarbodiimide |
| DIGE | difference gel electrophoresis |
| DMAPA | dimethylaminopropylamine |
| DMCS | dimethylchlorosilane |
| DME | $\alpha,\omega$-dicarboxylic acid methyl esters |
| DMOX | 4,4-dimethyloxazoline |
| DNP | dinitrophenyl |
| DNPH | 2,4-dinitrophenylhydrazine |
| DNPU | 3,5-dinitrophenyl urethane |
| DP | degree of polymerization |
| DRI | differential refractive index |
| DRIFT | diffuse reflectance Fourier transform infrared |
| DSC | *N*,*N*′-disuccinimidylcarbonate |
| DSP | diarrhoeic poisoning |
| DTX | dinophysistoxins |
| ECD | electron-capture detector |
| ECF | ethyl chloroformate |
| ECL | equivalent chain length |
| ECN | equivalent carbon number |
| ED | electrodialysis |
| ED | extractive distillation |
| EDMA | ethylene glycol dimethacrylate |
| EDTA | ethylenediaminetetraacetic acid |
| ee | enantiomer excess |
| EG | ethylene glycol |
| EGA | ethylene glycol adipate |
| EHPA | mono-2-ethylhexyl ester |
| EI | electron ionization |
| ELCD | electrolytic conductivity detector |
| ELSD | evaporative light-scattering detector |
| EOF | electroosmotic flow |
| EPA | Environmental Protection Agency |
| ESCA | electron spectroscopy for chemical analysis |
| ESI | electrospray ionization |
| EtG | ethyl glucoronide |
| FAB | fast atom bombardment |
| FAEE | fatty acid ethyl ester |
| FAME | fatty acid methyl ester |
| FDA | Food and Drug Administration |
| FDNB | 1-fluoro-2,4-dinitrobenzene |
| FFA | free fatty acid |
| FFPPC | forced flow PPC |
| FID | flame ionization detector |

DropBooks

| | |
|---|---|
| FMOC | fluoronylmethyl chloroformate |
| FPD | flame photometric detector |
| FTD | flame thermionic detector |
| FT-IR | Fourier transform infrared spectrometry |
| FT-Raman | Fourier transform Raman |
| GC | gas chromatography |
| GC-FTIR | gas chromatography – Fourier transform infrared spectrometry |
| GC-IRMS | gas chromatography – isotope ratio mass spectrometry |
| GC-MS | gas chromatography – mass spectrometry |
| GC-MS/MS | GC with coupled or tandem MS |
| GFAA | graphite furnace atomic absorption |
| GFC | gel filtration chromatography |
| GLP | Good Laboratory Practice |
| GPC | gel permeation chromatography |
| HAS | human serum albumin |
| HDC | hydrodynamic chromatography |
| HDEHP | di-(2-ethylhexyl)orthophosphoric acid |
| HETEs | hydroxyeicosatetraenes |
| HETP | height equivalent to one theoretical plate |
| HFB | heptafluorobutyryl |
| HI | hydrophobic interaction |
| HIC | hydrophilic interaction chromatography |
| HIC-CXC | hydrophilic interaction – cation exchange chromatography |
| HMDS | hexamethyldisilazine |
| HOM | humic organic matter |
| HOMO | highest occupied molecular orbital |
| HPA | heteropolyacid |
| HPALC | high performance affinity liquid chromatography |
| HPIC | high performance ion chromatography |
| HPLC | high performance liquid chromatography |
| HPLC-CSP | HPLC-chiral stationary phases |
| HPTLC | high performance thin-layer chromatography |
| HRGC | high resolution gas chromatography |
| HS | humic substances |
| HSCCC | high speed countercurrent chromatography |
| HSES | hydrostatic equilibrium system |
| HS-GC | headspace-gas chromatography |
| HSSI | *N*-hydroxysulfosuccinimide |
| HS-SPME | headspace-solid-phase microextraction |
| HTGC | high temperature gas chromatography |
| HVS | high volume sampling |
| i.d. | internal diameter |
| IAM | immobilized artificial membrane |
| IBCF | isobutyl chloroformate |
| IBOC | *N*-isobutyloxycarbonyl |
| ICP-AES | inductively coupled plasma-atomic emission spectroscopy |
| ICP-MS | inductively coupled plasma-mass spectrometry |
| ICR | ion cyclotron resonance |
| IE | ion exchange |
| IEC | ion exchange chromatography |
| IEF | isoelectric focusing |
| IIR | ion interaction reagent |
| IP-TLC | ion pair-thin-layer chromatography |
| IR | infrared |
| IS | internal standard |

| | |
|---|---|
| ITD | ion trap detector/detection |
| IXISS | ion exchange isothermal supersaturation |
| JT | Joule-Thompson |
| L/B | length-to-breadth |
| LAS | linear alkylbenzenesulfonate |
| LC | liquid chromatography |
| LDH | lactic acid dehydrogenase |
| LD-OPLC | long-distance overpressured-layer chromatography |
| LEC | liquid exclusion chromatography |
| LFER | linear free-energy relationship |
| LLE | liquid-liquid extraction |
| LOD | limit of detection |
| LOX | liquid oxygen |
| LSC | liquid-solid chromatography |
| LSER | linear solvation energy relationship |
| LSIMS | liquid secondary ion mass spectrometry |
| $LTB_4$ | leukotriene $B_4$ |
| LUMO | lowest unoccupied molecular orbital |
| LVS | low volume sampling |
| MA | macrocyclic antibiotic |
| MAC | multistage air compressor |
| MAGIC | monodisperse aerosol generator interface for chromatography |
| MALDI | matrix-assisted laser desorption ionization |
| MALDI-MS | matrix-assisted laser desorption ionization-mass spectrometer |
| MASE | microwave-assisted solvent extraction |
| MBTH | 3-methyl-2-benzothiazolinone hydrazone-HCl |
| MCF | methyl chloroformate |
| MCTA | microcrystalline cellulose triacetate |
| MDGC | multidimensional gas chromatography |
| MDMA | 3,4-methylenedioxymethamphetamine |
| ME | methyl ester |
| MEKC | micellar electrokinetic chromatography |
| MF | microfiltration |
| MIBK | methylisobutylketone |
| MID | multiple ion detection |
| MIPs | molecular imprinted polymers |
| MLL | mean list length |
| ML-OPLC | multi-layer overpressured-layer chromatography |
| MP | mobile phase |
| MPA | mobile phase additive |
| MPA | 3-mercaptopropionic acid |
| MPLC | medium pressure liquid chromatography |
| MS | mass spectrometry |
| MSD | mass selective detector/detection |
| MS-MS | tandem mass spectrometry |
| MSPD | matrix solid phase dispersion |
| MSTFA | *N*-methyl-*N*-trimethylsilyltrifluoroacetamide |
| MTBSTFA | *N*-*t*-butyldimethylsilyl-*N*-methyltrifluoroacetamide |
| MWD | molecular weight distribution |
| MWPC | multiwire proportional counters |
| NAC | *N*-acetyl-L-cysteine |
| NBP | 4-(*p*-nitrobenzyl)pyridine |
| NCA | National Council on Alcoholism |
| NCI-GC-MS | negative ion chemical ionization-GC-MS |
| nd | not determined |

DropBooks

| | |
|---|---|
| NF | nanofiltration |
| NFM | *N*-formylmorpholine |
| NHYD | ninhydrin |
| NIR | near-infrared spectroscopy |
| NMP | *N*-methylpyrrolidone |
| NMR | nuclear magnetic resonance |
| NN | neural network |
| NP | normal phase |
| NPD | nitrogen-phosporus detector |
| NQS | 1,2-naphthoquinone-4-sulfonate |
| NRTL | nonrandom two liquids |
| NSAID | nonsteroidal anti-inflammatory drugs |
| o.d. | outer diameter |
| OA | okadaic acid |
| ODS | octadecylsilica |
| ODS-1 | commercial octadecylsilica phase |
| OGCHI | ovoglycoprotein from chicken egg whites |
| OMCHI | chicken ovomucoid |
| OMCTS | octamethylcyclotetrasiloxane |
| OMTKY | turkey ovomucoid |
| OPA/MCE | *o*-phthalaldehyde/$\beta$-mercaptoethanol |
| O-PFBO | *O*-pentafluorobenzyloxime |
| OPLC | overpressured-layer liquid chromatography |
| OPTLC | overpressured TLC |
| OV-225 | commercial phase |
| oxo-ETEs | oxo-eicosatetraene |
| P & T | purge-and-trap |
| PA | photoacoustic |
| PA | polyacrylate |
| PAD | pulsed amphometric detector/detection |
| PAH | polyaromatic hydrocarbons |
| PAR | 4-(2-pyridylazo)resorcinol |
| PAS | photoacoustic spectroscopy |
| PB | particle beam |
| PCA | principal component analysis |
| PCB | polychlorinated biphenyl |
| PCDD | polychlorinated dibenzo-*p*-dioxin |
| PCDF | polychlorinated dibenzofuran |
| PCP | pentachlorophenol |
| PDB | Pee Dee Belimnite |
| PDCA | pyridine-2,6-dicarboxylate |
| PDMS | poly(dimethysiloxane) |
| PED | pulsed electrochemical detection |
| PEEK | polyetheretherketone |
| PEG | poly(ethylene glycol) |
| PEI | poly(ethyleneimine) |
| PEO | poly(ethylene oxide) |
| PETRA | pentaerythritol triacrylate |
| PFB | pentafluorobenzyl |
| PFBBr | pentafluorobenzyl bromide |
| PFBOA | pentafluorobenzyloxime |
| PFP | pentafluoropropionyl |
| PFPH | pentafluorophenylhydrazine |
| PGC | porous graphitic carbon |
| PGM | platinum group metals |

| | |
|---|---|
| PHDC | packed column hydrodynamic chromatography |
| PLOT | porous-layer open-tubular |
| PLS | partial least squares |
| PMMA | poly(methyl methacrylate) |
| PNBX | potassium *n*-butylxanthate |
| PNP | purine nucleoside phosphorylase |
| PPC | preparative planar thin-layer chromatography |
| PPO | 2,5-diphenyloxazole |
| PS | poly(styrene) |
| PSD | particle size distribution |
| PS-DVB | poly(styrene-divinylbenzene) |
| PSFC | packed-column supercritical fluid chromatography |
| PSP | paralytic poisoning |
| PTFE | poly(tetrafluoroethylene) |
| PTH | phenylthiohydantoin |
| PV | pervaporation |
| QSAR | quantitative structure-activity relationship |
| QSERR | quantitative structure enantioselective retention relationship |
| QSRR | quantitative structure-retention relationship |
| R/D | reflux-to-overhead ratio |
| RI | refractive index |
| RIA | radioimmunoassay |
| RLCCC | rotation locular countercurrent chromatography |
| RMM | relative molar mass |
| RO | reverse osmosis |
| RP | reversed-phase |
| RPC | reversed-phase chromatography |
| RS | Raman scattering |
| RSD | relative standard deviation |
| S/F | solvent-to-feed ratio |
| S/N | signal-to-noise ratio |
| SAC | strong acid cation |
| SARA | saturates, aromatics, resins and asphaltenes |
| SB/CD | short bed/continuous development |
| SBC | strong base anion |
| SBF | separation by flow |
| SCA | synthetic carrier ampholyte |
| SCOT | support-coated open-tubular |
| SD | standard deviation |
| SDE | simultaneous distillation-extraction |
| SDGlu | *N*-dodecanoyl-L-glutamate |
| SDS | sodium dodecyl sulfate |
| SDS-PAGE | sodium dodecyl sulfate-polyacrylamide gel electrophoresis |
| SDVal | sodium *N*-dodecanoyl-L-valinate |
| SDVB | styrene-divinylbenzene |
| SEC | size exclusion chromatography |
| SERRS | surface-enhanced resonance Raman scattering |
| SERS | surface-enhanced Raman scattering |
| SF | solvent front |
| $SF_6$ | sulfur hexafluoride |
| SFC | supercritical fluid chromatography |
| SFE | supercritical fluid extraction |
| SIM | selected ion monitoring |
| SIM | single ion monitoring |
| SMB | simulated moving bed |

DropBooks

| | |
|---|---|
| SN | separation number |
| SP | stationary phase |
| SPE | solid-phase extraction |
| SPM | simultaneous pyrolysis/methylation |
| SPME | solid-phase microextraction |
| SRB | sulfate-reducing bacteria |
| SS | supersaturated solution |
| STC | sodium taurocholate |
| STDC | sodium taurodeoxycholate |
| STX | saxitoxin |
| TA | time-to-amplitude |
| TAA | tetraalkylammonium |
| TAB | *N*-trifluoroacetyl-*n*-butyl ester |
| TBDMS | *t*-butyldimethylsilyl |
| TCD | thermal conductivity detector |
| TDS | total dissolved solids |
| TEA | thermal energy analyser |
| TEAA | triethylammonium acetate |
| TEAP | triethylammonium phosphate |
| TEG | triethylene glycol |
| TEPA | tetraethylenepentamine |
| TFA | trifluoroacetyl/trifluoroacetic acid |
| TGA | thermogravimetric analyser |
| THBC | 1,2,3,4-tetrahydro-$\beta$-carbolines |
| THCA | 11-nor-delta$^9$-tetrahydrocannabinol-9-carboxylic acid |
| THF | tetrahydrofuran |
| TIQ | 1,2,3,4-tetrahydroisoquinoline |
| TLC | thin-layer chromatography |
| TLC-MS | thin-layer chromatography-mass spectrometry |
| TLRC | thin-layer radiochromatography |
| TLV | threshold limit value |
| TMAH | tetramethylammonium hydroxide |
| TMCS | trimethylchlorosilane |
| TMPA | trimethylphenylammonium hydroxide |
| TMS | trimethylsilyl |
| TOC | total organic carbon |
| TOEDA | tetraoctylethylenediamine |
| TRIM | trimethylolpropane trimethacrylate |
| TSI | thermospray ionization |
| TTF | tetrathiafulvalene |
| UF | ultrafiltration |
| UHP | ultrahigh purity |
| UNIQUAC | universal quasichemical |
| UrdPase | uridine phosphorylase |
| UTP | uniform transmembrane pressure |
| UV/Vis | ultraviolet-visible |
| $V_C$ | total column capacity |
| VFA | volatile fatty acids |
| VLDL | very low-density lipoproteins |
| VLE | vapour-liquid equilibrium |
| VOCs | volatile organic chemicals |
| VPO | vapour pressure osmometry |
| $V_R$ | retention volume of the solute |
| $V_{SF}$ | retention volume of solvent front |
| WAC | weak acid cation |

| | |
|---|---|
| WBA | weak base anion |
| WCOT | wall-coated open-tubular |
| WPC | whey protein concentrates |
| XE-60 | commercial phase |
| XRF | X-ray fluorescence |
| ZDDP | zinc dialkyldithiophosphate |
| $\beta$-CD | $\beta$-cyclodextrin |

# 4. ANALYTICAL CHIRAL SEPARATION METHODS (IUPAC RECOMMENDATIONS 1997)

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## Abstract

In recent years there has been considerable interest in the synthesis and separation of enantiomers of organic compounds especially because of their importance in the biochemistry and pharmaceutical industry. Frequently the methods used for the separations, for monitoring the progress of an asymmetric synthesis or optical purity of the products are chromatographic with either liquids, gases, or supercritical fluids as the mobile phase. More recently capillary electrophoresis has been added as an analytical chiral separation method.

These applications have led to a number of terms and expressions in addition to those commonly used or recently recommended for the chemistry and physical properties of chiral compounds. This Nomenclature provides the descriptions and definitions for additional terms particularly related to analytical separation methods, and to the formation and enantiomeric purity of chiral products

DropBooks

## Introduction

Enantiomers are two chemically identical molecular species which differ from each other as non-superposable mirror images. The most simple and vivid model for enantiomeric structures is the two hands, left and right. Enantiomers, in addition to diastereomers and *cis-trans*-isomers, are thus a special case of stereoisomers.

The chirality (handedness) of enantiomeric molecules is caused by the presence of one or more chirality elements (chirality axis, chirality plane, or chirality centre, e.g. asymmetric carbon atom) in their structure. The chirality sense and optical activity of the enantiomers are determined by their absolute configuration, i.e. the spatial arrangement of the atoms in the molecule. In contrast to their conformation, the configuration of enantiomers cannot be changed without a change in the connectivity of constituent atoms. Designation of the configuration of enantiomers should be made in accordance with the Cahn-Ingold-Prelog *R*, *S*-system. The Delta-Lambda designations for enantiomers of octahedral complexes and the D,L Fischer-Rosanoff designations for amino acids and sugars are also in use.

Conventional chemical synthesis, in contrast to asymmetric synthesis, deals mostly with the transformations of achiral compounds. If these reactions result in the formation of a chirality element in the molecule, the reaction product appears to be an equivalent mixture of a pair of enantiomers, a racemate, which is optically inactive. Racemates are also formed through racemisation of chiral compounds. Racemates crystallize in the form of a racemic compound or, less frequently, as a conglomerate.

Separation of the enantiomers comprising the racemate, i.e. the resolution of the racemate, is a common problem in stereochemical research as well as in the preparation of biologically active compounds, in particular, drugs. The problem is that in contrast to distereomers and all the other types of isomeric species,